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Original Article

STUDY OF BC_3F_2 POPULATION FOR VARIABILITY PARAMETERS, GENETIC ADVANCE AND HERITABILITY IN MAIZE (*ZEA MAYS* L.)

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ABSTRACT

BC_3F_2 population of maize derived from cross between UMI 79 and UMI 936(w) and repeated backcrossing with UMI 79 was used in the study for variability parameters, genetic advance and heritability. The data on days to tasseling, days to silking, days to maturity, plant height, cob length, cob diameter, number of rows per cob, number of grains per row, cob weight, shelling %, hundred grain weight and grain yield per plant for BC_3F_2plants were recorded. The plants recorded moderate variability (GCV-10% to 20%) for plant height, cob diameter, number of grains per row and cob weight. However, it recorded low variability (GCV<10) for remaining traits. The moderate to high GCV gives an indication of justifiable variability among the genotypes with respect to these characters and therefore gives scope for further improvement of these traits through selection. For traits cob diameter, number of grains per row, cob weight and grain yield per plant, the PCV was higher than the corresponding GCV showing the role of environment in these characters. Minor variations between PCV and GCV values for rest of the traits under study shows the limited role of environment in these characters and they were mostly governed by the genetic factors. Selection for improvement of such characters will be rewarding. The variability parameters of BC_3F_2 progenies revealed that the traits viz., plant height, days to tasseling, days to silking, cob length, cob diameter, number of rows per cob, cob weight, shelling %, 100 grain weight and grain yield per plant have exhibited high to moderate heritability followed by high to moderate genetic advance. This clearly denoted that these traits are governed largely by additive gene effect which may be favourably exploited for further improvement by selection. Low heritability followed by moderate to high genetic advance was observed for number of grains per row indicating that the traits are governed by additive gene effects. The low heritability being exhibited may be attributed to high environmental effects. Intensive selection may be effective in such cases. Moderate heritability but low genetic advance observed in BC_3F_2 progenies for days to maturity indicates epistatis and dominant gene action and selection for this trait may not be rewarding. The traits could be exploited through heterosis breeding once the introgression is complete.

***KEYWORDS:** Maize, Variability Parameters, Genetic Advance, Heritability*

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INTRODUCTION

Maize (*Zea mays.* L) is the world's most widely cultivated cereal crop and an essential food source for millions of world's poor. It ranks among one of the four principal crops of the world. It is a widely grown C_4 crop with a high rate of photosynthetic activity leading to high grain and biomass yield potential. It is predominantly a cross-pollinating species, a feature that has contributed to its broad morphological variability and geographical adaptability. Plant breeders are commonly faced with problems of handling segregating populations and selection procedures. Mean and variability are the important factors for selection. Mean serves as a basis for eliminating undesirable crosses or progenies. Variability helps to choose a potential cross or progeny since variability indicates the extent of recombination for

Initiating effective selection procedures. An insight into the magnitude of variability present in a crop species is of utmost importance as it provides the basis for effective selection. The relative magnitude of variation available in a population can be measured by coefficient of variation and is used in comparing the relative variability of two or more sets of measurements which are entirely in different units.

The phenotypic coefficient of variation is the observable variation present in a character or in a population; it includes both genotypic and environmental components of variation and as a result, its magnitude differs under different environmental conditions. The genotypic coefficient of variation on the other hand, is the component of variation which is due to genotypic differences among individuals within a population and is the main concern of plant breeders. Fisher (1918) partitioned the total genetic variance (σ^2A) into (i) additive genetic variance (σ^2A), which is the sum of additive genetic variances contributed by individual loci (ii) Dominance variance (σ^2D) component which results from intra allelic interaction of genes at segregating loci (iii) epistatic variance (σ^2I) results from inter allelic interaction of genes at segregating loci. The genotypic co-efficient of variation provide a mean to study the genetic variability generated in quantitative characters (Johnson *et al.,* 1955). Selection for the improvement of quantitative traits can be effective only when segregating generation's posses the potential variability. Breeding potentials of a cross between varieties or inbreds are judged by the number of desirable transgressive segregants. The probability of obtaining superior lines can be worked out in early generations through the estimates of first and second order degrees of statistics if genetic variation is available (Pooni *et al.,*, 1992)

Comstock (1955) reported that phenotype associated with a given genotype varies with the environment. This leads to complete inconsistency of genotypic value, a different value of a given genotype relative to every variance of environment major or minor.. In order to know the breeding utility of this variability and selection value of various quantitative traits, it is essential to determine various components and heritable proportion of variability.

Heritability provides the magnitude of inheritance whereas the genetic advance is a measure of genetic gain under selection. Warner (1952) has suggested different technique for estimating the degree of heritability in crop plant which is based on parent offspring regression variance component from an analysis of variance and approximation of non-heritable variance from genetically uniform population to estimate the total genetic variance.

In the present study, the important biometrical traits *viz.*, days to tasseling, days to silking, days to maturity, plant height, cob length, cob diameter, number of rows per cob, number of grains per row, cob weight, shelling %, 100 grain weight and grain yield per plant were studied in the BC_3F_2 generation derived from cross between UMI 79 and UMI 936(w) and repeated backcrossing with UMI 79.

The following objective was designed for the present investigation

- To study the variability parameters, genetic advance and heritability for important biometrical traits in maize.

MATERIAL AND METHODS

UMI 79 and UMI 936 were crossed and resultant progenies were repeatedly backcrossed to UMI 79 to create BC_3F_2 population. The data on days to tasseling, days to silking, days to maturity, plant height, cob length, cob diameter, number of rows per cob, number of grains per row, cob weight, shelling %, hundred grain weight and grain yield per plant for BC_3F_2plants were recorded.

Days to Tasseling

It was recorded as number of days from sowing to when plants start to shed pollen.

Days to Silking

It was recorded as number of days from sowing to when plants haveemerged silks 2-3 cm long.

Days to Maturity

It was recorded as number of days from sowing to when leaves start to dry.

Plant Height (cm)

It was measured from ground level to the tip of the tassel after milk stage and expressed in cm.

Cob Length (cm)

It was measured from one end of the cob to next end and was expressed in cm.

Cob Diameter (cm)

The maximum diameter of the cob was measured and was expressed in cm.

Number of Rows per Cob

Number of rows on each cob was counted.

Number of Grains Per Row

Number of grains in each row was counted and average was noted.

Cob Weight (g)

Weight of each cob was recorded and was expressed in grams.

Shelling %

Grain yield per cob was divided by cob weight to get the shelling %.

100 Grain Weight (g)

A total of 100 randomly selected grains per cob were weighed at 12 per cent moisture content and expressed in grams.

Grain yield per Plant (g)

The single cob harvested per plant was shelled and grain weight was recorded as grain yield per plant and expressed in grams.

The various genetic parameters like variability, GCV, PCV, heritability and genetic advance as per cent mean were worked out for the BC_3F_2 progenies by adopting the formulae given by Johnson *et al.*, (1955).

Phenotypic and Genotypic Variance

The average variance observed in the parent UMI 79 and UMI 936(w) were considered as environmental

variance. The genotypic variance of each progeny was estimated by subtracting the estimated environmental variance from the phenotypic variance.

Environmental variance (Ve) = Average phenotypic variance of both the parents

Phenotypic variance (Vp) = Variance of population

Genotypic variance (Vg) = Vp – Ve

Phenotypic and Genotypic Coefficients of Variability

- **Phenotypic Coefficient of Variation (%)**

$$PCV = \frac{\sqrt{Vp}}{Mean} \text{ X } 100$$

- **Genotypic Coefficient of Variation (%)**

$$GCV = \frac{\sqrt{Vg}}{Mean} \text{ X } 100$$

The PCV and GCV values were categorized as follows (Sivasubramanian and Menon, 1973).

Table 1

PCV and GCV	Category
< 10 per cent	Low
10 – 20 per cent	Moderate
> 20 per cent	High

Heritability (h^2)

Heritability (h^2) estimate in broad sense and expected genetic advance (GA) at five per cent selection intensity were estimated by the methods devised by Lush (1940) and expressed in percentage.

$$\text{Heritability } (h^2) = \frac{Vg}{Vp} \text{ X } 100$$

The heritability % was categorized as suggested by Robinson *et al.* (1949).

Table 2

Heritability (in %)	Category
< 30	Low
31 – 60	Medium
> 60	High

Genetic Advance (GA)

Genetic advance was estimated by the method formulated by Johnson *et al*. (1955).

Genetic advance = k x h^2 x σp

Where,

h^2 = Heritability in broad sense

σp = Phenotypic standard deviation

k = Selection differential (at 5 % selection intensity) (*i.e.*) 2.06 (Falconer, 1960)

Genetic Advance as Percent of Mean

The genetic advance as per cent of mean was categorized as suggested by Johnson *et al*. (1955)

$$\text{GA as per cent of mean} = \frac{\text{Genetic advance}}{\text{Grand mean}} \times 100$$

GA was categorized as:

Table 3

GA Per cent Value	Category
< 10 per cent	Low
10 - 20 per cent	Moderate
> 20 per cent	High

EXPERIMENTAL RESULTS

Days to Tasseling

The flowering ranged from 52 to 65 with a mean of 58.12 almost similar to the recurrent parent, UMI 79 (59.40 days). The trait exhibited low PCV (6.48), low GCV (6.00), high heritability (85.57%) and moderate genetic advance as per cent of mean (11.43%) (Table 1).

Days to Silking

The mean days taken for silking was recorded as 61.20 days similar to recurrent parent, UMI 79 (62.20 days) with minimum 55 and maximum 68 days. The variability parameters *viz.*, PCV (6.14) and GCV (5.57) were found to be low for the trait. High heritability (82.27%) with moderate genetic advance as per cent of mean (10.40%) was recorded (Table 1).

Days to Maturity

Days to maturity had a mean of 91 days with minimum 87 and maximum 102 days. It is almost similar to the recurrent parent, UMI 79 (93.60 days). Low PCV (3.92), low GCV (2.44), medium heritability (38.82%) and low genetic advance as per cent of mean (3.14 %) was observed for the trait in this progeny (Table 1)

Plant Height (cm)

The plant height ranged from 58.60 cm to 133.90 cm. It showed a mean value of 99.92 almost similar to the recurrent parent, UMI 79 (98.47 cm). The trait also exhibited moderate levels of PCV (16.98), GCV (16.86), high heritability (98.52%) and genetic advance as per cent of mean value (34.47 %) (Table 1)

Cob Length (cm)

For cob length, progenies exhibited a range from 8.00 to14.10 cm with a mean of 10.83 which is similar to the recurrent parent, UMI 79 (10.68 cm). The trait exhibited moderate PCV (13.96), low GCV (9.49), medium heritability (46.15 %) and moderate genetic advance as per cent of mean (13.28%) in this progeny (Table 1).

Cob Diameter (cm)

Cob diameter ranged between 6.20 and 14.20 cm with mean value of 10.08 cm similar to the recurrent parent (10.76 cm). Regarding variability parameters, high PCV (21.88), moderate GCV (14.49), medium heritability (43.86%) and moderate genetic advance as per cent of mean (19.77%) was observed (Table 1).

Number of Rows per Cob

Number of kernel rows per cob was varying from 10.00 to 16.00 were observed with mean value of 12.52 similar to the recurrent parent UMI 79 (11.20). Moderate PCV (14.74) but low GCV (9.48) was noted. The trait showed medium heritability (41.34%) and moderate genetic advance as per cent of mean (12.56%) (Table 1).

Number of Grains per Row

Number of grains per row ranged from 7.00 to 21.00 with a mean value of 13.25. High PCV (27.09), moderate GCV (14.77), low heritability (29.71%) and moderate genetic advance as per cent of mean (16.58%) was recorded (Table 1).

Cob Weight (g)

The cob weight registered a minimum of 17.88g and a maximum of 40.97g with a mean value of 27.30g. as far as variability parameters is concerned, high PCV (21.81), moderate GCV (16.72), medium heritability (58.78%) and high genetic advance as per cent of mean (26.41%) were noted (Table 1).

Shelling %

Progenies showed a range from 54.13 to 77.96% for shelling. A mean value of 68.10 % almost similar to the recurrent parent UMI 79 (66.47%) was noted. Moderate PCV (10.70), low GCV (8.72), high heritability (66.33%) and moderate genetic advance as per cent of mean (14.63%) was observed for this trait (Table 1).

100 Grain Weight (g)

The hundred grain weight varied from 13.92 to 22.40 g with mean value of 18.34 g similar to the recurrent parent UMI 79 (19.00g). Low PCV (6.57), low GCV (5.62), high heritability (73.18%) and low genetic advance as per cent of mean (9.91%) was recorded (Table 1).

Grain yield per Plant (g)

Grain yield varied from 13.68 to 27.65g with a mean value of 18.28g similar to the recurrent parent UMI 79 (17.44g). Moderate PCV (15.84), low GCV (9.08), medium heritability (32.84%) and medium genetic advance as per cent of mean (10.72%) was recorded (Table 1).

PCV (%), GCV (%), heritability (%) and GA as mean (%) for all the characters have been depicted in Fig. 1-4.

DISCUSSIONS

- The plants recorded moderate variability (GCV-10% to 20%) for plant height, cob diameter, number of grains per row and cob weight. However, it recorded low variability (GCV<10) for remaining traits. The moderate to high GCV gives an indication of justifiable variability among the genotypes with respect to these characters and therefore gives scope for further improvement of these traits through selection.
- For traits cob diameter, number of grains per row, cob weight and grain yield per plant, the PCV was higher than the corresponding GCV showing the role of environment in these characters. Minor variations between PCV and GCV values for rest of the traits under study shows the limited role of environment in these characters and they were mostly governed by the genetic factors. Selection for improvement of such characters will be rewarding.
- The variability parameters of BC_3F_2 progenies revealed that the traits *viz.*, plant height, days to tasseling, days to silking, cob length, cob diameter, number of rows per cob, cob weight, shelling %, 100 grain weight and grain yield per plant have exhibited high to moderate heritability followed by high to moderate genetic advance. This clearly denoted that these traits are governed largely by additive gene effect which may be favourably exploited for further improvement by selection.
- Low heritability followed by moderate to high genetic advance was observed for number of grains per row indicating that the traits are governed by additive gene effects. The low heritability being exhibited may be attributed to high environmental effects. Intensive selection may be effective in such cases.
- Moderate heritability but low genetic advance observed in BC_3F_2 progenies for days to maturity indicates epistatis and dominant gene action and selection for this trait may not be rewarding. The traits could be exploited through heterosis breeding once the introgression is complete.

Table 4: Variability Parameters Observed in the BC_3F_2 Generation

Trait	Grand mean					BC_3 F_2						
				Range								
	P1	P2	BC_3 F_2	Min.	Max.	Vp	Vg	PCV (%)	GCV (%)	h^2 (%)	GA	GA (as Percent of Mean)
Days to tasseling	53.40 ±0.81	56.40 ±0.4	58.12± 0.47	52.00	65.00	14.20	12.15	6.48	6.00	85.57	6.64	11.43
Days to silking	56.60 ±0.86	59.20 ±0.4	61.20± 0.47	55.00	68.00	14.10	11.60	6.14	5.57	82.27	6.36	10.40
Days to maturity	97.60 ±1.57	93.60 ±0.81	91.00± 0.44	87.00	102.00	12.75	4.95	3.92	2.44	38.82	2.86	3.14
Plant height (cm)	90.12 ±0.96	97.60 ±0.88	99.92± 1.90	58.60	133.90	287.92	283.65	16.98	16.86	98.52	34.44	34.47
Cob length (cm)	9.06± 0.32	10.68 ±0.79	10.83± 0.19	8.00	14.10	2.29	1.06	13.96	9.49	46.15	1.44	13.28
Cob diameter (cm)	8.54± 0.82	12.76 ±1.10	10.08± 0.27	6.20	14.20	4.87	2.14	21.88	14.49	43.86	1.99	19.77
No: of rows per cob	9.60± 0.49	10.80 ±0.75	12.52± 0.23	10.00	16.00	3.41	1.41	14.74	9.48	41.34	1.57	12.56

Table 4: Contd.,												
No: of grains per row	8.60± 1.08	9.40± 1.69	13.25± 0.44	7.00	21.00	12.88	3.83	27.09	14.77	29.71	2.19	16.58
Cob weight (g)	18.38 ±1.74	22.98 ±1.29	27.30± 0.74	17.8 8	40.97	35.47	20.85	21.81	16.72	58.78	7.21	26.41
Shelling %	64.68 ±0.29	70.82 ±1.52	68.10± 0.90	54.1 3	77.96	53.13	35.24	10.70	8.72	66.33	9.96	14.63
100 grain weight (g)	16.09 ±0.29	19.30 ±0.27	18.34± 0.15	13.9 2	22.40	1.45	1.06	6.57	5.62	73.18	1.82	9.91
Grain yield per plant (g)	11.89 ±1.24	17.44 ±1.09	18.28± 0.36	13.6 8	27.65	8.38	2.75	15.84	9.08	32.84	1.96	10.72

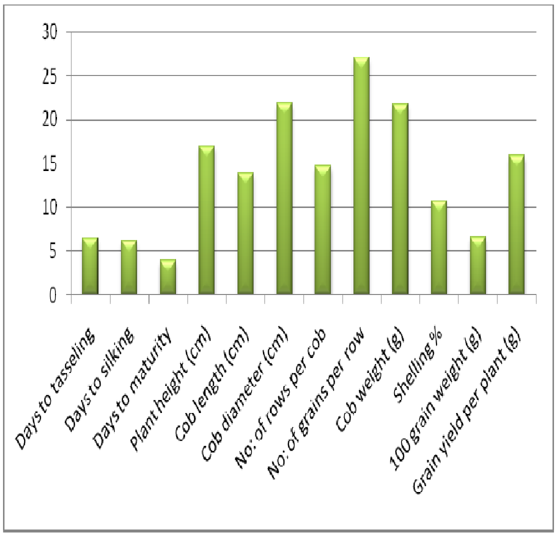

Figure 1: PCV Estimates (in %) in BC_3F_2 Generation

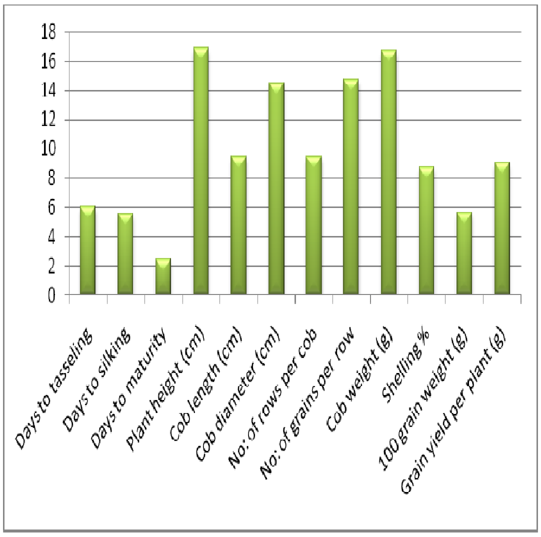

Figure 2: GCV Estimates (in %) in BC_3F_2 Generation

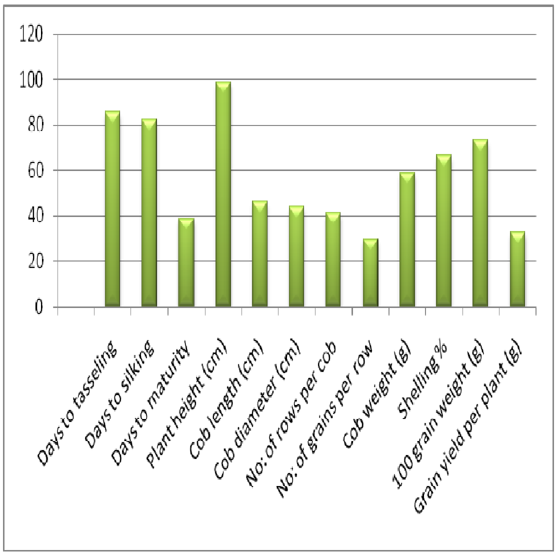

Figure 3: Heritability Estimates (in %) in BC_3F_2 Generation

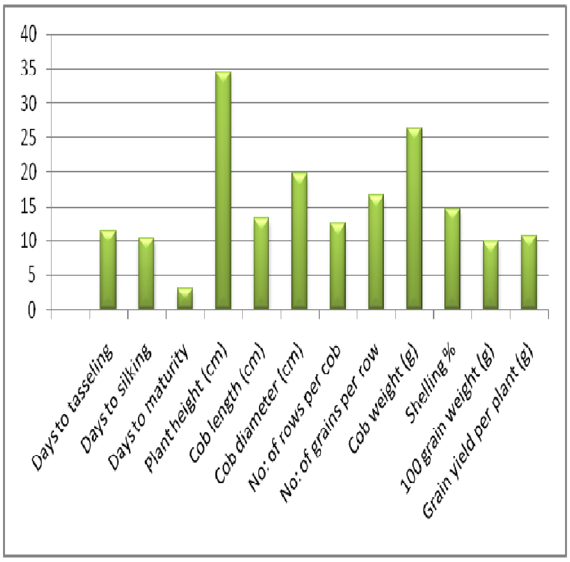

Figure 4: GA as Mean (in %) in BC_3F_2 Generation

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